

# Sustainable Trail Construction Techniques







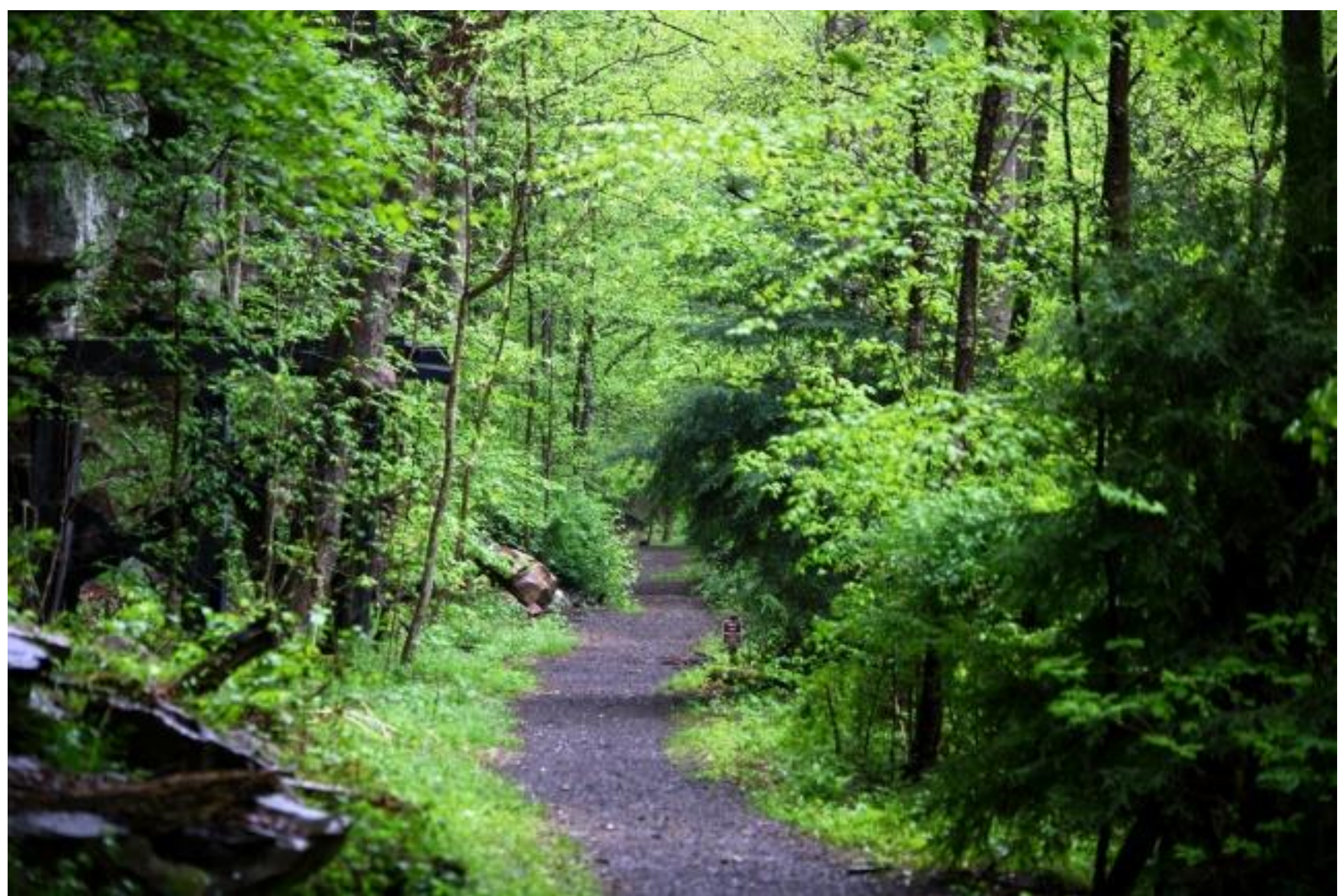


# Forest Trails Alliance



***Mission:***  
***Empower passionate***  
***people with the skills and***  
***resources to develop***  
***engaging sustainable trail.***





# EXPERIENTIAL TRAIL BUILDING

ROADS = Practical infrastructure based on functional transit needs  
Developed by engineers and planners

AGENCY TRAILS =

- Often practical infrastructure with less experiential focus
- May [NOT] be developed by someone who enjoys trails or has adequate experience or funding
- Developed by engineers and planners
- Often subbed out to contractors for who will are cheapest bidders
- Built to minimal project standards to achieve compensation
- Rarely includes regional trail stakeholders

USER BUILT TRAILS =

- Experiential infrastructure is based in part on emotion and desired feelings
- Developed by local stakeholders who are not limited by funding
- Usually reflects a higher degree of on-the-ground reconnaissance and feature highlights
- Can inspire a broader range of contributors and professionals



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- Client Session, Identify client objectives [on site]





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- Lab Work, Concept map and details





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- Field Survey, Evaluate concept corridor for additional information [GPS]





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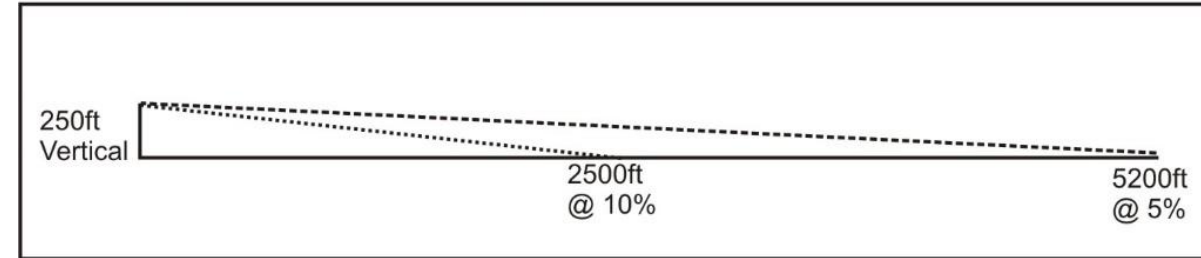
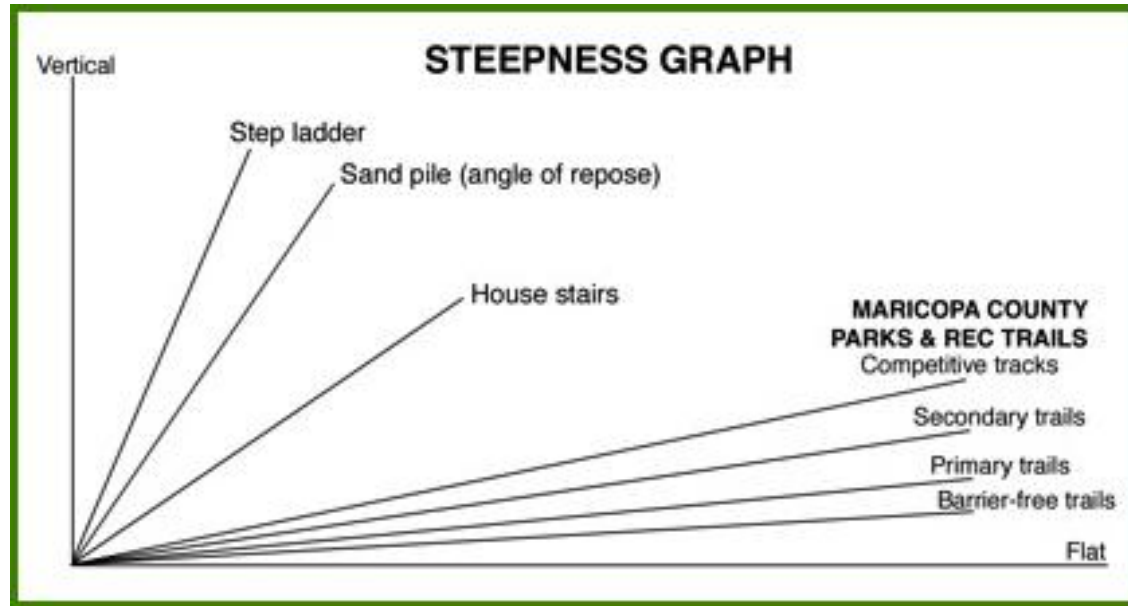
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- CONSTRUCTION



# Forest Trails Alliance







Trail Cupping gone wrong

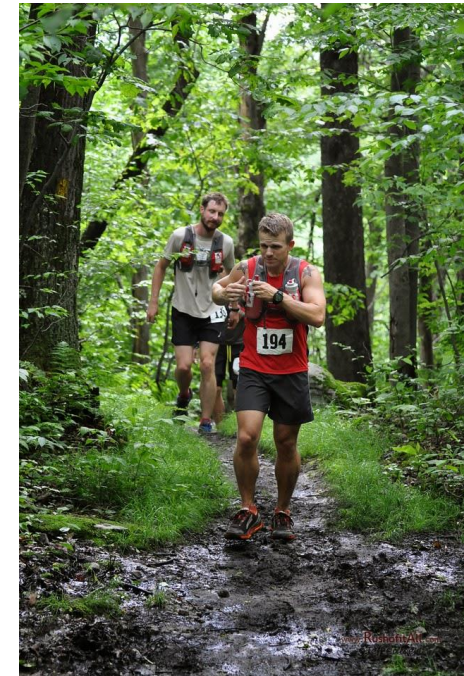
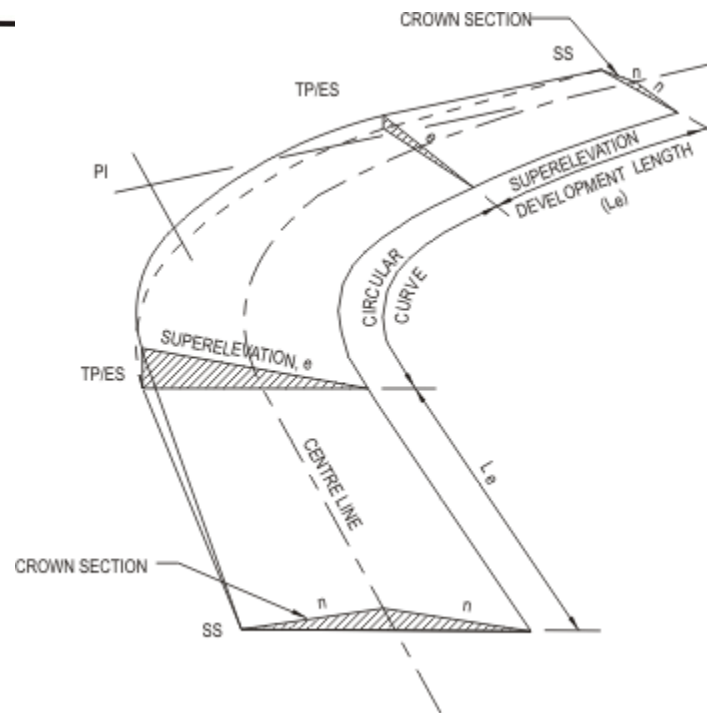




# Super Elevation and users in motion

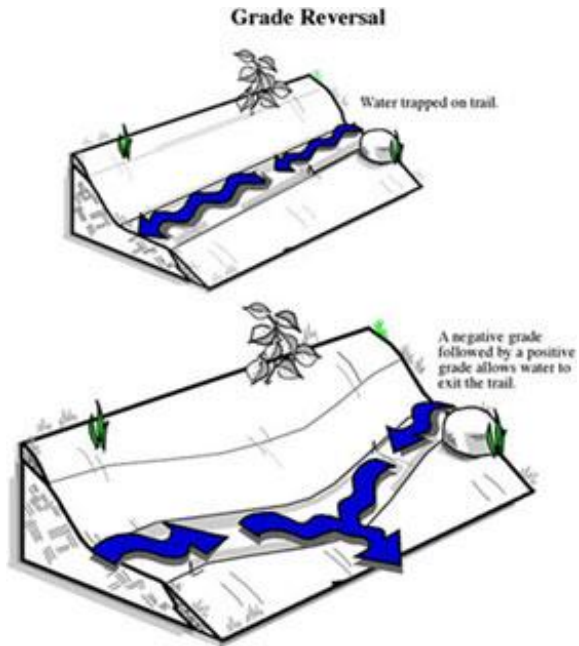


- Keep forces at right angles to tread
- If anticipated speed and sharpness of arc requires camber greater than 10% (max pedestrian camber), create a two stage camber with a steeper outside camber





# Grade Reversals... undulations





# For the love of Switch Backs!

*Switch Backs are any 180 degree change in direction on a side slope.*

*Rolling Turns are any turn or switch back designed to accommodate a cyclist's broader turning radius.*





# Anchored Switch Backs

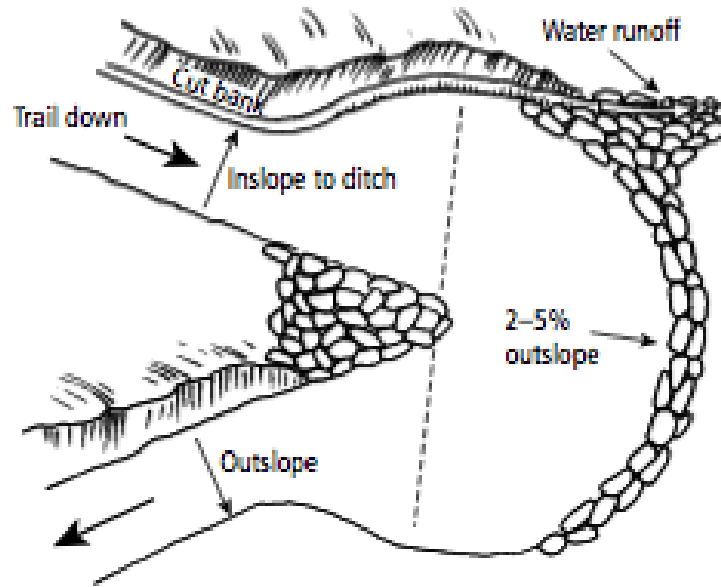
- Radiuses around a fixed object like a tree or boulder
- Provides a raised obstacle to pivot around and prevent edging
- Provides a peripheral anchor point for navigation
- Provides an unique area for landscaping



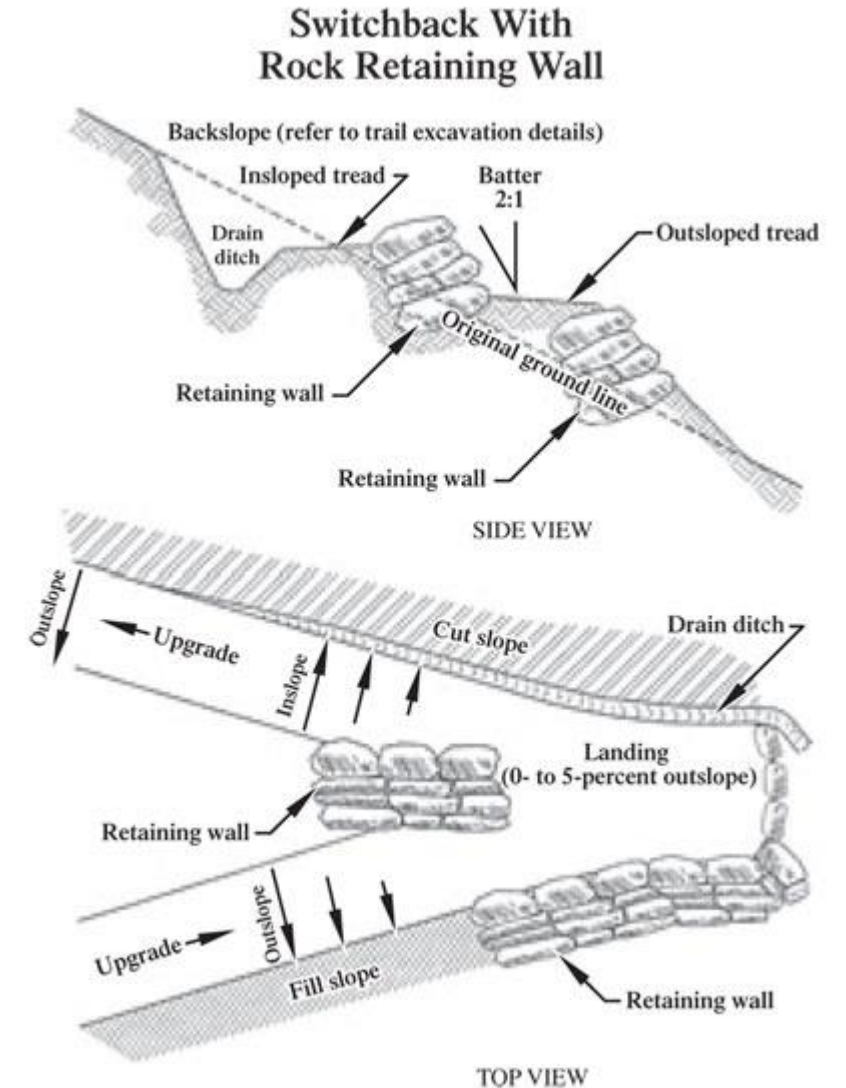


# Rolling Crown Switch Backs

- Diverts Water to outside of turn
- Can be more difficult to do on steeper side slopes
- High wear and failure rate from Cupping



**Figure 13-12. Switchbacks help the user climb a steep slope at a comfortable grade.**





# Hollowed Switch Backs

- Ideal for steeper side slopes
- Water drains to center then across trail below
- Maximizes materials for a broader and more level turn

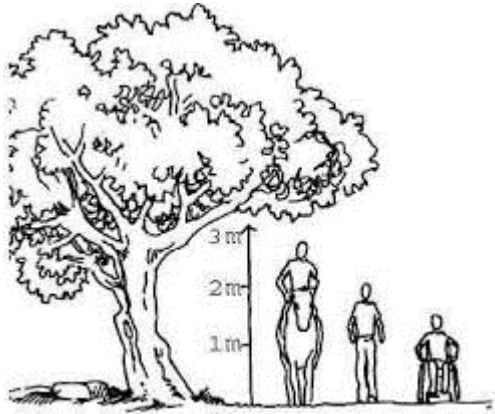








# TREES



Trees are common minor control points for trails.

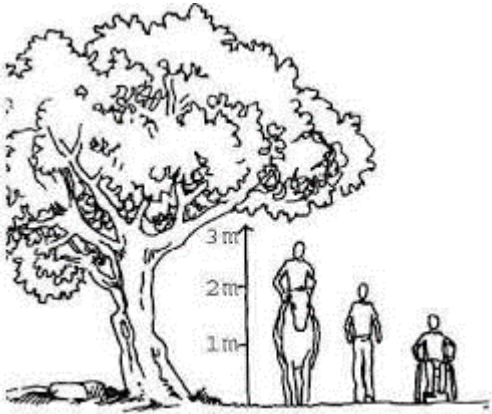
Its best to avoid being too close, to avoid impacting soil density.

Try and stay out of the drip edge when possible or around sensitive trees.





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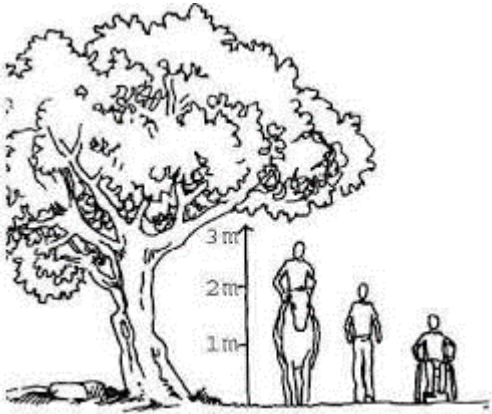


Consider all trees to be decorative and avoid poor pruning techniques.

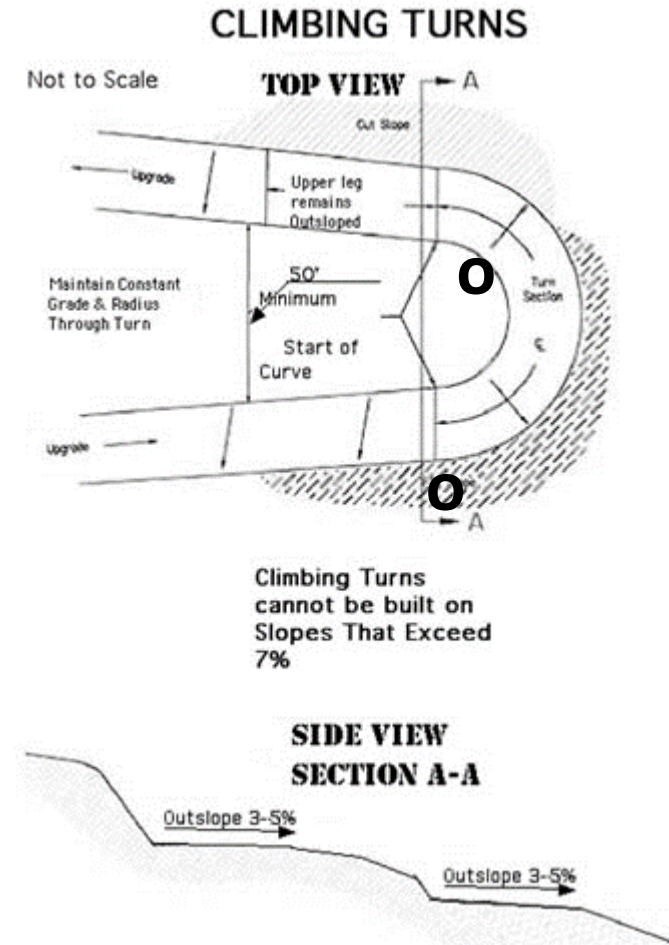




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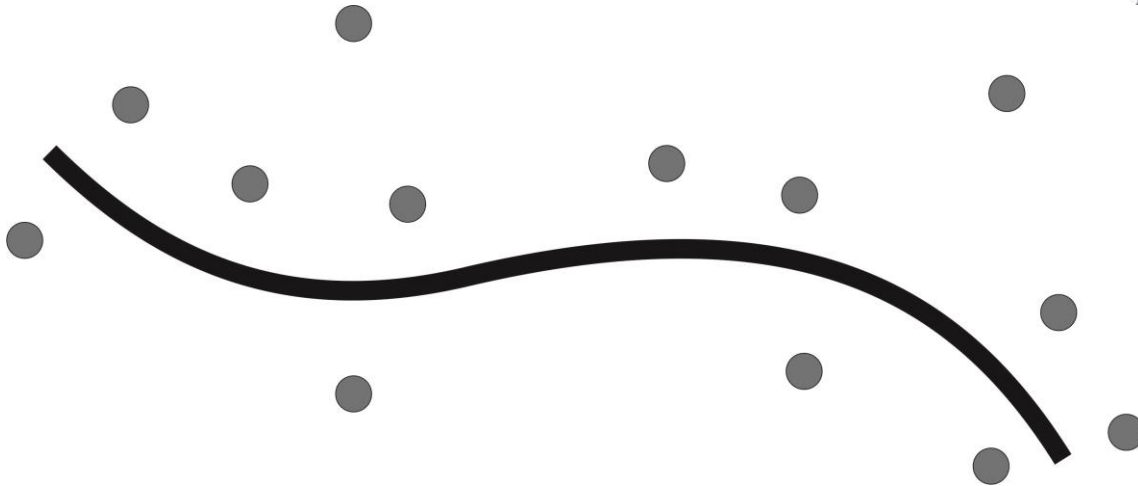
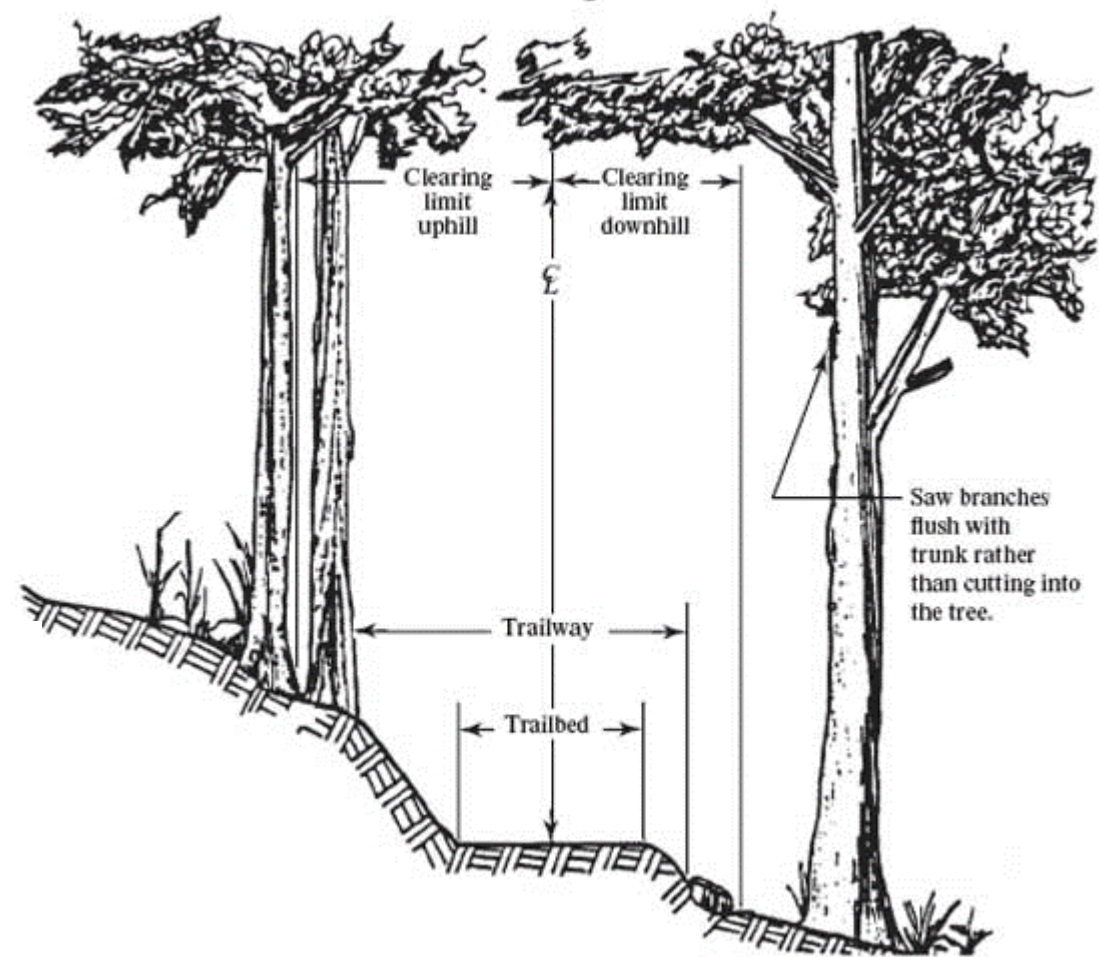
Cyclists lean into turns. Avoid having trees close to the trail on the inside of arcs and on the lower outside of switch backs.





# USE TREES TO CREATE AN HISTORIC FEEL TO THE TRAIL

Historic trails are often defined by a corridor of adjacent Trees. This is because trails captured more water and were related to openings which offer more light.





# CONSTRUCTION





# Soil Moisture

**5-10% for best compaction**

**Will hold shape when compressed**

**Will break apart when dropped**

**Dry soils shrink as much as 20%**





# Process

## FLOW STICK

- Provides architectural tool to create consistent arcs and transitions
- Used to confirm drain depths and pitch
- Evens out segmented pins and when chalked is more visible.





# Process

## The Equipment

### The Pusher



Good production for;

- Grades that are not excessive
- Full bench Construction

### The Digger, and small skid steer



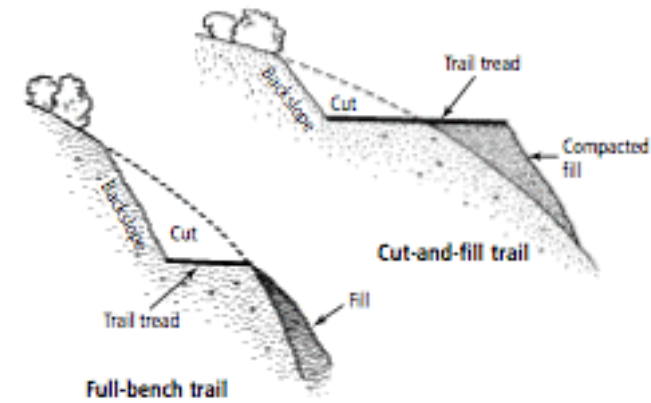
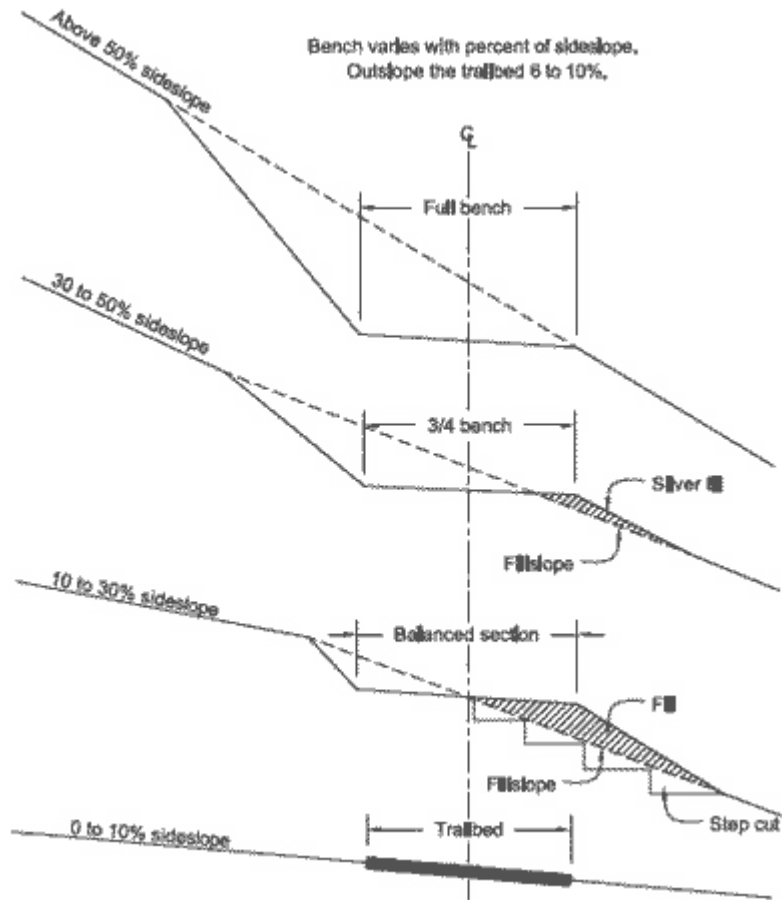
Ideal for;

- Detail work like stacking rock
- Separating Organics
- Partial bench construction
- Blade can be oriented like a trowel  
increased compaction



# Process

## FULL BENCH OR PARTIAL



**Figure 13-7. Full-bench and cut-and-fill trails provide safe travel across steep slopes.**

### Old Partial Bench Technique

- No preparation of the toe counter slope of the fill area
- Inadequate or no compaction
- Mismatched density of cut and fill areas which leads to uneven settling

### New Partial Bench Technique

- All organics concentrated below toe
- Toe, fill area counter sloped
- Toe fill area compacted
- Cut area double dug to even settling and knit soils
- Recovering of soils other than wear line



# Process

## COMPACTION

Compaction can be facilitated by a sheeps foot roller compactor or plate compactor





# Erosion

Splash erosion is the displacement of particulates caused by rain drops impacting the dirt.

- Reduce broadcasting of dirt below trail
- Keep shoulders steep (30-45deg) to define trail and reduce exposed material
- Cover exposed soils with organics other than wear area of tread





# Erosion

Sheet Erosion is the movement of water across slopes when the ground cannot absorb water fast enough. Areas that lack proper vegetative cover are susceptible

Out sloped trail helps stop consolidation on trail...  
If maintained

- Keep pitch to 5%
- Frequent grade reversals reduce consolidation of water
- Place grade reversals at all ephemeral drains



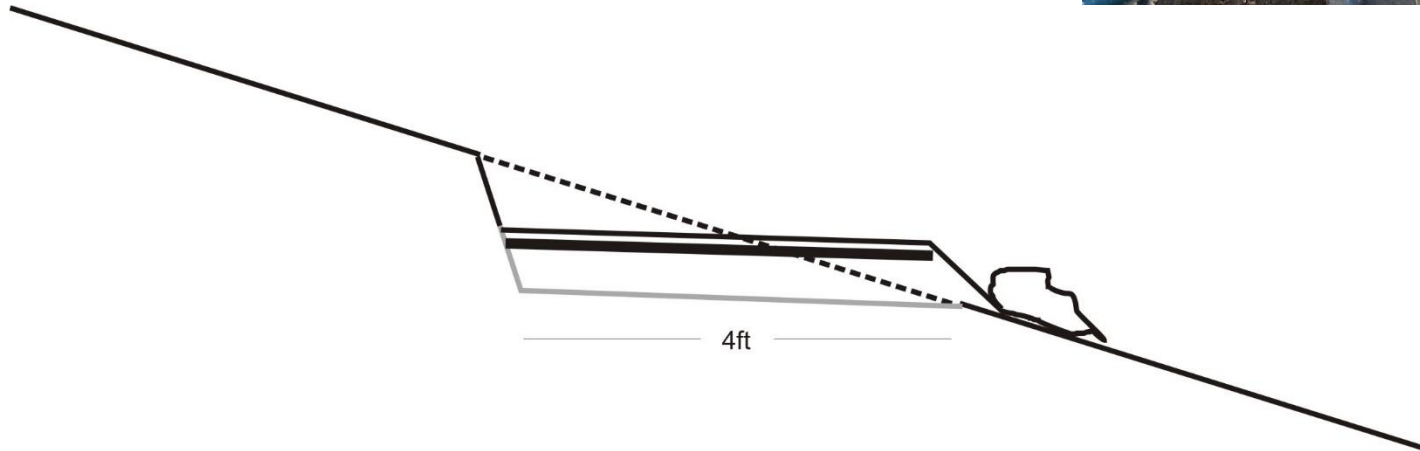


# ADDITIONAL MEASURES

## Bench Waddles

*Bench Waddles are a consolidation of organics to the toe of the lower shoulder.*

*This filters sediment and makes the organics available for pulling back on top of exposed dirt shoulders.*





# ADDITIONAL MEASURES

## Trail Seasoning

*If the trail is built without compaction in dryer months, it may be good to let cure for a rainy season to densify soils.*

*This allows for in-sloping of drains to act as sediment catches and additional organics to filter Run-off.*

*The trail can be covered with organics to reduce Splash erosion.*

